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ABSTRACT

The evolution of scholarly publishing is a good illustration of recent changes in technology. Many organizations are developing and operating electronic publishing systems that will change the way scholars, scientists, and technical professionals access information. Scholars obtain access to periodical literature in their fields through journal subscriptions, book purchases, library use (including photocopying), interlibrary loan, article reprints, and a few other less frequently used services. In the United States, there are several commercial vendors of electronic full text databases. Although most electronic publishing systems in use today rely on telecommunications, distributed storage media with dense capacity such as compact disk read-only memories (CD-ROMs) are becoming more popular. Electronic publishing may change the content, process, and format of journals. The concept of electronic journals remains largely a concept, yet one that is driving a great deal of research, development, and entrepreneurship. Publishing standardization, the rising cost of print journal publication, and the increasing power and rapid decline in prices for microcomputers, storage, and output devices, give rise to a reasonable expectation that electronic journals will be a viable channel for scholarly communication. (SRT)

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THE ELECTRONIC JOURNAL:
A Review of Trends and Their Implications for Scholarly Communication

Presented to the
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Abstract

This paper reviews the literature on recent efforts to improve scholarly communication through the development of electronic document delivery systems. A historical overview of earlier print-based efforts to streamline journal distribution is also provided. American and Western European efforts are reviewed, with a predominant focus on the former. Emphasis is given to the economic and social implications for three constituencies: scholars (as authors and users of journal literature), publishers, and university libraries. Equal emphasis is placed on near and long term scenarios as they are evolving in the marketplace.

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INTRODUCTION

The new media environment is a moving target. Rapid progress in the design of information storage and retrieval technology is only one indicator of the elusive nature of that environment. Along with changes in technology have come new entrepreneurial opportunities and new social and economic concerns. The evolution of scholarly journal publishing is a good illustration. In 1945, Bush published a widely referenced article describing a personal vision of a desktop terminal called "Memex" which would provide the scholar with convenient and quick access to the full text of periodical literature in his field. Since that time, attempts have been made to realize that vision in a number of ways, both through paper-based systems and, more recently, using computer technology.

Today, many organizations are developing and operating electronic publishing systems. Publishers increasingly demonstrate interest in the commercial potential of such systems. This paper highlights the substantial momentum of changes in the means of creating and accessing information among scholars, scientists and technical professionals. An attempt is made to introduce the reader to the topic through an overview of industry developments. The emphasis is on the nature and scope of the changes taking place, the direction such efforts are headed, the interests affected most directly, and the desirability of certain outcomes. The issue of precisely when electronic information products and services will reach a certain level of market penetration for scholarly publishing is not considered in detail. The premise is that it is less useful to predict the future than

it is to be aware of possible contingencies. This paper is directed at the social and technical possibilities being pursued in the arena of scholarly publishing, and it argues for the relative desirability of some over others. Among the outcomes advocated are the hybridization of central and distributed systems; increased involvement by universities, including the subsidization of faculty and student use of electronic databases; an increase in the amount of voluntary collaboration and experimentation among publishing organizations; and greater attention given to the topic of scholarly publishing by communication researchers.

McDonald and Bush (1982) classify periodical literature into two broad categories: 1) Scholarly, Scientific, or Technical (SST); and 2) Other Serials. SST journals are defined as:

> serials which are published primarily for the use of scholarly, academic, scientific, professional, or technical groups. Rather than exclusively report news items or materials of a popular or entertaining type, such serials publish technical papers, research reports, or material of a scholarly nature. Some employ a "refereeing" system whereby submitted manuscripts are reviewed by a group of the submitting author's peers. Articles appearing in such journals are often written in a technical language or level of detail which is not familiar to a general reader. They may also publish news reports or accept advertising, but their primary function is to communicate original research findings and/or scholarly writing.
>
> (McDonald and Bush, 1982, sec.4, p.3)

The category of "Other Serials" contains all types not described above, including "newspapers, newsletters, general audience magazines and periodicals, trade magazines, magazines aimed at managers and executives, financial reporting services, abstracts, indexes, and regularly-published bibliographies" (sec.4, p.4).

In 1982, the authors estimated that about one third (32.6%) of all publishers produce serials falling into the SST category. This paper focuses on SST literature and the implications of electronic document delivery for publishers, libraries, and end users.

1. PAPER-BASED JOURNAL PUBLISHING

1.1. Delivery Systems

Scholarly publishing predominantly is paper-based, and few would argue that the situation will change much in the next several years. Scholars obtain access to the periodical literature in their fields in a number of ways, including journal subscriptions, book purchases, library use (including photocopying), interlibrary loan, article reprints, and a few other less-frequently used services, discussed below.

In a major study commissioned in 1981 by the U.S. Copyright Office, it was estimated that 23.6% of all library photocopying was in response to interlibrary loan (ILL) requests (McDonald and Bush, 1982, sec.3, p.28). When distances are greater than intracity, many libraries will order photocopies using computer-based ILL services, such as that offered by OCLC (Online Computer Library Center, Inc.) in Dublin, Ohio. OCLC operates an international computer network providing many computer based services to libraries, including the servicing of an interlibrary loan cooperative. Many (not all) supplying libraries will charge recipient libraries for access to their collections because of the labor involved in retrieving the item from the stacks and photocopying or sending the original journal by mail. In turn,

recipient libraries typically pass the charges on to the end user.

Another option for the scholar is research-for-hire. A well known firm providing such service is Information On Demand, Inc. (IOD), headquartered in Berkeley, California. With staff located at major resarch libraries across the country, including several in California, Cornell, MIT, Harvard, and the Library of Congress, IOD is able to provide a distant scholar with photocopy access to virtually any journal in print. IOD's services may be requested by mail, phone or through an online system.

An "article clearinghouse" is a firm which houses a considerable collection of specialized periodical literature, used to provide photocopies or tearsheets of articles to requesting individuals or institutions. For instance, University Microfilms International (UMI), a subsidiary of Britain's International Thompson, provides photocopy access to a massive journal collection. UMI's primary purpose in holding such a large collection is to create microfilmed versions of printed publications. However, they obtain additional revenue from this asset by operating a photocopying service. Scientific and technical societies which provide abstracting services for their members, such as the American Chemical Society and the American Society for Metals, also earn extra revenue by offering similar services. As with IOD and UMI, ordering can be done by mail, phone, or online.

Unfortunately for the scholar whose research is not subsidized, prices per document are barely affordable for

extensive use of interlibrary loan, research-for-hire, and article clearinghouses. The labor-intensive nature of these services results in high operating costs which are passed on to users. The federal government appears to have acknowledged this drawback in paper-based document delivery by withdrawing efforts to finance a centralized service called the "National Periodicals Center (NPC)."

Serious efforts have been made in the U.S. to create a federally-funded national periodicals system with a high level of central control over storage and transactions. The system would rely on paper-based journals as well as microforms (microfilm and microfiche). An online index and order placement system would be used, and distribution would be in hard copy. In April 1977, a report was prepared by a task force from the National Commission on Libraries and Information Science (NCLIS), which recommended the formation of local, state and regional library periodicals systems; a NPC (perhaps more than one, if warranted); and the use of existing national libraries and other unique collections to back up the first two levels (NCLIS, 1977, p.1).

In response to the NCLIS report, a 1978 study was commissioned by the Library of Congress. The Council on Library Resources, Inc. (CLR) provided technical and economic analyses for a national program and recommended the construction of buildings and the acquisition of a massive journal collection. The study also recommended that "finding tools" be developed for cataloging and indexing the NPC collection, and that relationships with publishers be strengthened in order to satisfy their economic interests and gain their cooperation. Estimated

costs for construction of the center, envisioned as a modular warehouse facility, were $5.5 to $6.5 million (CLR, 1978).

In October of 1979, NCLIS hired the research firm of Arthur D. Little, Inc. (ADL) to evaluate and integrate the ideas advanced in the 1977 and 1978 reports. Among the key questions raised by ADL were whether publishers and libraries would cooperate, and whether the service might not reach technological obsolescence in a short time due to the advancement of electronic systems. ADL speculated that a paper-based system would have minor impact on reducing the heavy burden on interlibrary loan traffic, reprint sales, photocopying within a library, and photocopying from private subscriptions (NCLIS, 1979). The federal government appears to have made a tacit commitment to a laissez faire approach, and seems to have abandoned the idea of a National Periodicals Center. According to Biggs (1984), the lack of action should be attributed to the absence of decisive leadership both in Congress and the library community. However, it is equally plausible that the present level technological and organizational uncertainty is the primary barrier.

1.2. The Economics of Journal Publishing

Sanders (1984) of the American Chemical Society, a publisher of 19 scientific journals, cites the five major operational costs involved in production of individual journals: composition, presswork and binding, paper, postage, and mailing. His illustration accounts for the costs of production incurred beyond the considerable ones associated with the manuscript stages of

writing, reviewing, editing. Sanders notes that production costs are volume-sensitive, suggesting that low-volume publications would suffer most from being tied to a paper-based mode of delivery.

Sanders also has given illustrative revenue analyses for chemistry journals. As with costs, journal revenues are volume-sensitive. Larger circulations mean greater opportunity for advertising sales. Large circulation scholarly journals, such as the Journal of the American Chemical Society and the New England Journal of Medicine, illustrate the relative attraction to advertisers. These publications contain many full-page color ads, while many smaller-circulation journals in chemistry and medicine contain very few. A consequence of larger circulations and increased advertising is lower subscription rates. Those journals which do not sell as much advertising typically must acquire their operating revenue from higher subscription prices.

1.3. The Protection of Copyright

From the perspective of the scholarly, scientific, and technical publishing industry, the future warrants concern about the myriad of potential means scholars may have to circumvent payment for access to and use of journals. Already, the low cost of photocopying has made it possible for scholars to become more selective about the number of journals to which they subscribe. The benefit they enjoy is the convenience of obtaining photocopies of selected articles from "fringe publications" which only infrequently publish articles of relevance to their own

research. As a result, scholars can achieve greater breadth in their coverage of relevant literature while not suffering from the inordinate costs of numerous subscriptions. While this situation is desirable from a researcher's perspective, the publisher may reasonably need to fear the loss of revenue when the only subscribers to many journals are libraries.

One of the private sector's efforts to provide publishers with compensation for this perceived loss of revenue has been the formation of the Copyright Clearance Center (CCC). This nonprofit corporation, established in 1977, exists for the purpose of providing a means for publishers to collect royalties from users who require more than "fair use" in photocopying. CCC currently has a membership of over 2200 users (primarily libraries), information brokers and government agencies, who pay for the reproduction of publishers' copyrighted works. CCC acts as a single point of clearance on behalf of approximately 1300 publishers. This offers publishers a potential means to capture new revenue, while saving the user of copyrighted materials from having to seek permission directly from several publishers (CCC Promotional Literature, 1984).

Although current figures are unavailable, in 1980/81 the CCC returned to publishers only 45 cents out of every dollar collected, the rest going towards administrative expenses. There appears to be little incentive for libraries to carefully police the use of photocopying equipment on behalf of publishers and the CCC. From a library's perspective, the drain on staff resources, with no compensation in return, makes the task too difficult. From the scholar's perspective, a too-watchful eye is likely to

discourage library use. Consequently, the paper-based CCC concept may be ineffective in enabling publishers to control the situation brought on by photocopying. For this reason, the prospect of electronic journals has long-term appeal for publishers.

2. ELECTRONIC JOURNAL PUBLISHING

2.1. Developments in the U.S.

The perceived need for convenient electronic access to large collections of literature may lead to an eventual increase in federal support. U.S. Representative Toricelli has proposed that greater availability of the biomedical literature be promoted through federal funding. He has proposed that the National Library of Medicine use modern technology to "make available at a reasonable cost the full text results of biomedical research, current and archival, to the Nation's medical libraries for use by the scientific community" (U.S. Congress, 3/8/84, p.4). As with many bills introduced in Congress, this one received little attention and was not voted on. However, if some version of this bill eventually is enacted, the medical research literature (including journals) could be distributed either by telecommunications or by the physical distribution of storage media containing the information. Given the priority of medical research, it seems likely that some type of electronic document delivery system will be developed for this purpose. Such a system will pave the way for other subject areas.

Crude experimentation in the United States dates as far back as the initial implementation of the Department of Defense's

Advanced Research Project Agency Network (ARPANET) in 1968-69. ARPA, with personnel from Stanford Research Institute, UCLA, the University of Utah and other organizations, by 1975 had installed a network of 50 host computers at 38 sites, including Hawaii, Norway and England. The ARPANET user community cooperatively shares data, algorithms and ideas, combining publishing and computer conferencing in one system. Another U.S. project of historical importance is the Electronic Information Exchange System (EIES). Hiltz and Turoff (1978) discuss the system at length, citing the benefits of national and international "invisible colleges" which can and do evolve through computer conferencing.

Today, there are several commercial vendors or "brokers" of electronic full text databases. The following are some of the major U.S. organizations involved in such activity:

* Mead Corporation (Lexis and Nexis):

Lexis serves the legal profession, carrying U.S. federal and state statutes and case law, British and French case law, and the full text of several law reviews, including those of:

- Columbia
- Howard
- U. of Chicago
- U. of Pennsylvania
- U. of Virginia
- Yale

Nexis, focusing on general business, carries several national international newspapers and magazines, including:

- American Banker and ABA Banking Journal
- New York Times, Washington Post
- Data Communications, Electronics, High Technology
- Business Week, The Economist, Financial Times
- Chemical Week, Chemical Engineering

* Lockheed Corporation (Dialog): Full text services include:

  - Commerce Business Daily
  - Drug Information Fulltext
  - Standard & Poor's News
  - Harvard Business Review

* Thyssen-Bonemisza, Inc. (Bibliographic Retrieval Service): Full text services include:

  - 19 Journals of the American Chemical Society
  - American Academic Encyclopedia
  - Critical Care Medical Library (24 prominent textbooks in emergency and critical care medicine)

In addition to these organizations, there are several other potential major competitors in the delivery of full text scholarly, scientific, technical and professional information. Compuserve (H & R Block), The Source (Readers Digest), and Dow Jones News Retrieval Service (Dow Jones, Inc.) presently carry wire reports, encyclopedias, and general business periodicals.

Other developments in electronic document delivery in the U.S. include the use of point-to-point facsimile. An example would be where library A transmits a facsimile photocopy to library B using telecommunications. Many telefacsimile experiments were undertaken in 1984, resulting in widely varying conclusions about cost effectiveness (Library Systems, 11/84). As one market experiment illustrates, the infrastructure for such a service would be the existing interlibrary loan online system, which enables one institution to search for and order a document from another (Information Hotline, 3/84).

Facsimile technology also can be used to create electronic databases. Using the model of an article clearinghouse, an organization such as UMI's Article Clearinghouse could scan

documents, provide electronic indexing, and allow users to tap into the facsimile database by telephone lines. The most established form of electronic publishing is much simpler, making use of "character-coded" text and having no graphics. The key difference between character-coded document delivery and facsimile is the level at which the information is digitized. With facsimile, the smallest indivisible unit is the page. With character-coded document delivery, the smallest unit is the individual character on the page. Facsimile takes up much more storage per page than does a page of character-coded information, and requires a correspondingly longer transmission time.

In the long term, it will be much more desirable for electronic journal databases, whether centralized or distributed, to contain character-coded rather than facsimile journal text. The storage demands for facsimile are much greater and there is less flexibility in the types of output devices which may be used. Character-coded text can be output on a simple dot matrix printer or on a very high resolution laser printer. Another factor in favor of character-coded databases is the capability to do "freetext searching," that is, to search throughout the full text of a document looking for specific strings of characters.

Most of the electronic publishing systems in use today rely on long-distance telecommunications networks. Unfortunately, telephone charges act as a barrier to database use. However, we now are seeing increasing attention being paid to <u>distributed</u> storage media with dense capacity. Of central interest are the new compact disk read-only memories (CD-ROMs), which are laser

optical disks with dense capacity for storing text and graphics. Instead of using the phone line, optical disks could be mailed to researchers or libraries. This development makes it possible for publishers to sell subscriptions to disks containing journals instead of offering online access. In 1985, the Society for Scholarly Publishing's annual meeting focused on optical memory as a critical technology in the industry's future. Several major scholarly publishing organizations have shown interest in developing applications for CD-ROMs, including McGraw-Hill, New England Journal of Medicine, the American Chemical Society, and the American Mathematical Society (SSP "Special Report").

Besides developments in the storage and retrieval technology for electronic publishing, there are also advances being made in the entry of text into databases. The present state of optical character recognition (OCR) technology introduces the potential to enjoy the benefits of character-coded databases without the laborious cost of duplicating keystrokes. Rather than retype a paper-based journal article to enter it into the electronic database, one can scan the journal, page by page, using an OCR reader. This process is not as labor-intensive as it may seem, since OCR readers exist which can turn pages of a book automatically. The concept of OCR technology is flawed, however, in that these machines presently are not capable of recognizing all of the many different type fonts used to print journals. At best, it is a somewhat cumbersome solution to the text entry problem, albeit one with immediate appeal to database entrepreneurs.

It is desirable for electronic journals to be generated

directly from the machine-readable text files which were used in typesetting the paper-based journal. Unfortunately, neither journal publishers nor the companies who do their printing tend to retain copies of these computer tapes for very long after an issue is in print. However, this situation may change as publishers are attracted to the potential for reaching a wider circulation through electronic document delivery.

An important barrier standing before the development of character-coded databases is the reliance of many publications (particularly in physics, biology, chemistry, and medicine) on graphic illustrations such as photographs, detailed drawings, tables, and charts. Existing commercial systems do not reproduce most graphic information, since their systems (e.g., BRS, Lockheed's Dialog, Compuserve, and Mead Corporation's Lexis and Nexis) can only output alphanumeric characters. In addition, photocomposition tapes for journals with graphics do not contain graphic information. Instead, a typesetter allows space for the graphics to be manually "stripped in" just prior to printing. When composition and delivery systems are developed which can economically handle graphic information as computer input, there will be a stronger appeal for journal publishers to enter the market. Another factor leading to vast improvements in the aesthetic quality of computer output is the use of digital typesetting. Today, a page of character-coded text can be typeset and printed, using digital fonts, and bear remarkable fidelity to the publisher's own bound journal.

One development in the U.S. which is helping to streamline

publishers' composition costs is the "Electronic Manuscript Project" of the Association of American Publishers. The AAP and the Council on Library Resources have co-sponsored a three-year effort to develop a format designed to permit "anyone's electronic manuscript to be processed on anyone else's computer." The AAP standard is an application of the International Standards Organization's "Standardized Generalized Markup Language" (SMGL). More than forty publishing industry groups worldwide have participated in the project. Technical specialists (production specialists, typsetters, etc.) and developers and vendors of SMGL processing software will implement the standard (AAP Press Release, 1/17/86).

2.2. Western Europe

In comparison with European efforts, electronic publishing in the United States is more ad hoc and its planning is less centralized. As with the early development of videotex, the Europeans seem to be advancing faster into developing systems designed specifically for delivery of scientific and technical literature. The most likely explanation for this is that the European efforts are heavily subsidized by government funding.

"Euronet" is the name of the packet-switching computer network established by the Commission of European Communities (CEC), which became operational in late 1979 (Page, 1984). Today, one network which uses Euronet is the Direct Information Access Network for Europe (DIANE). DIANE uses a common command language to permit access to several hundred databases from more than 35 hosts. Much of the information contained in these

databases is scientific, technical, legal, social and economic (Schmittroth, 1983). Through the support of the CEC, DIANE is serving to improve the exchange of information within the European Community. There is also a protective tariff structure designed to discourage U.S. penetration into the European information market (Page, 1984).

The CEC has been involved in financing electronic publishing experiments. Projects receive roughly 25% of their funding from this source (reported at "Electronic Document Delivery and Electronic Publishing: A Conference Organised by the Commission of the European Communities," Luxembourg, June 13 & 14, 1984). The objectives of the experiments are to measure user acceptance and system performance, and answer economic and organizational questions (Gurnsey and Henderson, 1984). Among the interesting projects are the following: 1) Adonis: involves major European journal publishers, including Blackwell Scientific, Springer Verlag, and Elsevier Science Publishers; 2) BLEND (Birmingham and Loughborough Electronic Network Development): a group of information scientists experimenting with refereed electronic journals (this UK project includes a computer conferencing network called LINC [Loughborough Information Network Community]); 3) Invisible College: based at the National Institute for Higher Education in Ireland, and designed to link institutes in Ireland, the UK, and France (this system will contain "gray literature," such as unpublished manuscripts, conference papers, and technical reports); 4) Scientific Document Delivery System: a system for delivering the full text

of scientific publications, sponsored by an Italian inter-university consortium and the University of Milan; 5) Verlag Technische Regelwerke (VTR) Project: VTR is a committee of DIN, the national standards institute of West Germany. They are developing a system which will be used to deliver scientific and technical literature in both character-coded and facsimile forms. As a part of DIN, the VTR project could develop national electronic document delivery standards, including guidelines for the use of digital typesetting, which would be imposed in Germany.

Of particular significance in European electronic document delivery activity are four key factors: 1) the rapidity with which European countries are moving into developing computer-based scholarly communication systems, 2) the many experimental projects taking place, 3) the large amount of inter-organizational and international collaboration taking place within Europe, and 4) the high level of government support.

3. IMPLICATIONS OF ELECTRONIC JOURNAL PUBLISHING SYSTEMS

It is useful to speculate on the potential changes which will come about through the use of a new communication technology. Our reason should be to examine the potential of a vision and decide whether it is worth pursuing or modifying. Many authors (e.g., Ackoff et al., 1976; Hiltz and Turoff, 1978; Lancaster, 1978; and King, 1981) have described scenarios of what an electronic publishing system for scholars might be like. King (1981) expresses well the essential elements which appear to be common in those scenarios:

> In the electronic journal system, articles will be prepared by authors using sophisticated text-editing systems. Article preparation may include joint writing of text through teleconferencing systems in which immediate peer review is possible, comments are made, and specific research questions can be answered.... The digital form of the unreviewed manuscript will be directly transmitted electronically to a publisher. The publisher will electronically transmit the manuscript to a subject editor, who will read the text by CRT or printout and make electronic notes concerning editorial and content quality. The subject editor may choose appropriate reviewers using a computer program that matches the profile of potential reviewers with the topics covered in the article. Other computer-stored information will be used to help screen reviewers, such as by affiliation and relationship to the authors, status of the most recent review, frequency of reviews, timeliness of response of previous reviews, and quality of reviews. The reviewers will respond to editors, and editors in turn to authors, by telecommunication, comparable to current teleconferencing processes for business purposes, address listings, and other such activities (King, 1981, p.309).

The technological possibilities for delivering such information have already been discussed. The implications of the combined processes of creating, storing and retrieving scholarly information using new information technologies are discussed below.

3.1. Shifting Boundaries: Content, Process and Format

Compaine and his associates (1984) have provided a broad general framework for viewing the nature of change in the new media environment. Their Program on Information Resources Policy at Harvard University monitors technological, market and regulatory factors which traditionally define the boundaries of the information industry. More importantly, the Program emphasizes the unstable nature of those boundaries. Instead of a traditional emphasis on the substitution effect of one delivery

system on another, Compaine suggests a more useful, organic approach to observing and participating in changes in the media environment. It is one which attends to the content, process, and format of the media. Media content is the information which is provided, process is the handling and transmitting of information, and format is the way in which it is presented to the user. "In essence, what is happening in the media arena is that the previously discrete and readily identifiable segments are merging into a more fluid industry, leading to dissolution of old groupings and crystallization of new" (Compaine, 1984, p.79).

In contrast to Compaine's perspective, one might narrowly construe the new media as one-to-one substitutes for old media. Levitt (1975) terms such an outlook "marketing myopia," citing an example from the freight transportation industry, which had traditionally been monopolized by the railroads. With the rapid development of superhighways and large capacity tractor trailors, trucking became a viable substitute for railroads. Investments poured into this new industry sector while many railroad companies struggled and faltered instead of seeing trucking as a natural extension of the business in which they were engaged, nameley, freight transportation. Indeed, the use of new media technologies may lead to competitve displacement of old ones, as measured by shifts in audience size and financial resources (Dimmick and Rothenbuhler, 1984). However, rather than focus on resource distribution, the following analysis emphasizes the process, content, and format of journal publishing and use.

The parties likely to be most directly affected by the diffusion of electronic scholarly journal publishing are scholars

(as authors and users), libraries, and publishers. The implications for these constituencies are examined from the perspective of potential changes in the content, process, and format of scholarly publishing.

3.1.1. Content

The content of scholarly, scientific, and technical literature may change due to electronic pubishing in part because of the speed at which such information reaches its target audiences. Information scientist and philosopher of science Derek de Solla Price coined the terms "invisible colleges" and "the affluent scientific commuter" (1963). He noted that the present ease of long-distance travel and communication, and the relative affluence of today's scientist compared with yesterday's, have led to a steady increase in the strength of informal networks:

> We [scientists] publish for the small group, forcing the pace as fast as it will go in a process that will force it harder yet. Only secondarily, with the inertia born of tradition, do we publish for the world at large.... It has made the scientific paper, in many ways, an art that is dead or dying (Price, 1963, p.91).

Price's observation reflects how the nature of content in scientific and technical publishing is changing. He notes that the turnaround time for publication in paper-based, juried journals is inadequte to the task of contributing to quick progress. A niche which may be filled by electronic publishing is the need for forums which permit the rapid exchange of information of an ephemeral type. This is a function best served by centralized systems which can be accessed by

telecommunications. Distributed systems based on subscriptions to storage media (such as CD-ROMs) may find their niche as an archival medium for the more traditional types of content.

A computer-based publishing system may allow some researchers not only to report on their analyses, but also to provide interested readers with raw data and the programs used to analyze it. Understanding, criticism, and replication can be more easily accomodated if space limitations do not restrict the type or amount of information an author provides. Given the decreasing cost of storage and distribution, document length restrictions need not be as great a concern as in paper-based publishing.

The powerful search capabilities of electronic databases may contribute to the homogenization of journal content. There currently are methods of assessing the impact of an author's work through the use of computer-based citation indexes and full text electronic databases will increase the power to do so. At a time when certain journals' primary distribution medium is electronic, it will be possible to determine not only the frequency with which articles are cited, but also the frequency in which they are read. Authors may begin to pattern their research after that which sells, potentially inducing undesirable homogeneity. However, the popularity of an article is only one indicator of its quality, and not a very valid one.

Advertising revenues, particularly from popular journals, will present substantial challenges and opportunities in the transformation from a print-based to an online journal. An

attractive opportunity for publishers, operators of centralized systems, and advertisers results from the fact that advertisements may be updated continually. This is particularly useful in scientific and technical fields, where new product developments occur frequently. Just as old movies on television are not accompanied by ads for products which no longer are sold, system operators can insert ads for new products and services with an older, but still popular article.

Another possible change in content is that publishers may eventually change the nature of what constitutes a "journal," "book," or "collection." At present, and likely in the near future, electronic journals and books simply are secondary outlets for paper-based literature. Thus, we currently have traditional books and journal issues available online. However, the journal "issue" may eventually become an artifact that is irrelevant for an electronic medium. The independent unit of publication for journals could shift to the individual article. Likewise, authors may cease to conceive of many "books," particularly collections on well-defined topics, in the same way. Rather, electronic indexing would allow us to search for and retrieve available documents written by a given author. New chapters could be added to such "books" as they are written and approved for publication. The possibility of a shift in the unit of publication may lead to a significant shift to such units of sale as the individual article or chapter, connect time, or scope of access to a database.

Today, many scholars pay for selective dissemination of information (SDI) searches on a regular basis. By designating a

profile of keywords to be used in searching online indexes, they are able to efficiently keep abreast of a wide range of developments across a large number of publications in their fields of interest. Electronic journal databases accessed by SDI profiles will enable scholars to increase the breadth and depth of their current awareness on topics of interest, extending well beyond what is affordable with paper-based journal subscriptions. Unlike the subscription model, where subscribers pay for articles they read as well as those which they do not, users of electronic journals may need to pay only for that which they retrieve from the system. By the same token, those who wish to maintain sufficient breadth in their coverage of the literature may do so by browsing electronically. Fortuitous landing on an interesting article outside the mainstream of one's focused areas would still be possible.

3.1.2. Process

Electronic publishing could significantly alter the processes of creating, storing, and transmitting scholarly, scientific, and technical literature. However, the exact scope of this change is a function not only of how the finished product is stored, but also of the process in which it is created. Electronic manuscripts, optical character recognition, computer generated graphics, and facsimile are some of the recently developed data input innovations for publishing.

In a shift to an electronic journal environment, new procedures would change the cost and revenue factors of

publishing in a number of ways. Estimates of operational costs for publishing an electronic journal, produced in tandem with its print counterpart, would require adding the cost factors of electronic indexing, text and graphics processing, storage, and telecommunications. However, assuming there will come a time when exclusively electronic publishing is commercially viable for some journals, production costs could exclude presswork, binding, and paper.

As researchers, some scholars may fear being "cut off" from the vital literature in their fields, due to lack of access to print journals in the library, and the high cost of their electronic substitutes. However, such organizations exist with the mission of serving, not exploiting, their constituencies. Publishers, whether for-profit or not, serve such audiences subscriptions (or association memberships) by pricing according to what they think (or hope) that market can bear. There is no reason to assume the laws of supply and demand will change simply because the delivery system changes.

Library journal acqusition policies could change significantly, depending on the degree of libraries' involvement in electronic document delivery. A controversy exists in the library community over the subject of libraries charging fees to their patrons for requested materials. The particular point of dispute is whether libraries, most of which rely on some level of taxpayer support, should charge for services which reasonably can be argued to be "public goods." "User fees," as these charges are called, can separate haves and have-nots, placing libraries in the undesirable position of gatekeepers. However, as Gell

(1983a) argues, user charges for public goods are neither new nor are they unjustified in some situations. She notes the use of bridges, highways, hospital and health services, and public utilities, all of which are subject to user fees.

Gell (1983b) argues that libraries are justified in charging users for searches of computer databases, particularly if not charging would require reallocation of resources away from other library functions. Perhaps pricing for electronic journals could be tiered, so as to provide at least a minimum level of access for an affordable price. Assuming that a library is seeking to reduce the size of its print journal collection by subscribing to electronic journals, it may be that the library can justify subsidizing and/or completely covering the cost of a limited number of articles per user within a given time period. Compaine (1984) envisions a situation where "Managers will have to explain the need to shift some funds from asset acquisition in the form of books, to expense categories for communications and data-base services" (p.115). Individual members of a university academic department may be allocated a certain amount of money each month, quarter, or year for retrieving articles from an electronic journal system.

Electronic journals may be perceived as a threat to libraries. However, the use of electronic journals does not imply the ultimate obsolescence of libraries as we know them. Rather, it simply implies that the demand for a journal, and whether it is available online, should be considered when a library is evaluating its subscription list. In essence, an

electronic journal system need only be viewed by the reference librarian as one more "library" among members of an interlibrary loan system. Perhaps what may occur is that, for routine access to some databases, the library will substitute its current role as physical intermediary and become a fiscal intermediary. In this way, access to frequently used types of information is distributed to where it is more accessible.

The potentially lower cost for the distribution of electronic journals compared to paper ones may lead publishers to charge higher prices for the latter. Publishers also may offer incentives for authors who comply with electronic manuscript standards, such as a reduction or elimination of page charges. (Many journals charge authors for the cost of processing articles prior to printing.) A precedent can be taken from the retail banking industry, with the advent of automatic tellers and home banking by computer. It has been said that banks are likely to initiate discriminatory pricing which reasonably favors the "good" customers who make less costly paperless transactions (Arlen, 1983).

No dominant organizational model exists for electronic journal publishing. However, there are two general approaches which appear likely. One is patterned after some of the commercial videotex and cable systems in operation, such as Knight-Ridder's "Viewtron" and Warner Communications' "QUBE," respectively. Knight-Ridder is a major newspaper publisher while Warner owns the cable channels Nickelodeon, The Movie Channel, and MTV. Consequently, these organizations have a competitive advantage over other information providers on their systems in

their ability to monitor what sells and what does not.

An alternative model is exemplified by such information brokers as H & R Block's Compuserve and Lockheed's Dialog. Unlike Viewtron and Gateway, Compuserve's and Dialog's owners are not heavily invested in publishing their online systems. The latter companies can be seen more as common carriers or "information utilities" in the sense that they are relatively neutral in their interest towards competition among the services they broker. An organization which appears particularly well-positioned to become a broker for electronic scholarly journals is the Copyright Clearance Center (CCC), discussed previously. Because of its close working relationships with thousands of publishers and libraries/users, the CCC has the organizational infrastructure to become an effective electronic link between these two groups.

3.1.3. Format

The format of journals could be dramatically different than paper-based journals. Journals stored electronically also offer an attractive substitute to microforms for archiving information. Not only does electronic archiving offer equal and greater storage density, it also has the potential to be far superior for random access and retrieval. In addition, while microforms are easily scratched, machine-readable files retain their fidelity indefinitely. Microform readers also tend to produce poor copy using photographic paper. In contrast, today's high quality non-impact digital printers are superior output devices. Laser

printers can be used for digital typesetting and for printing facsimile images at very high resolution with excellent contrast and grey scales.

The Online Computer Library Center (OCLC), in Dublin, Ohio, is developing a system which can be accessed over local area networks on locations such as college campuses. OCLC also is interested in realizing the potential of inexpensive high density storage, such as CD-ROMs (compact disk-read only memories) for carrying text and graphics. Rather than dialing up a central database by long-distance connection, scholars soon are likely to be able to connect locally with their library or academic department to retrieve journal articles. High resolution bit-map display screens and laser printers increasingly are becoming standard office automation equipment. OCLC envisions the day when a scholar may connect with a local journal database and retrieve an article for output on a display screen or a laser printer. Documents will be typeset to closely replicate the original printed version of an article including tables, scientific symbols, and graphics. Currently, the quality of printed output from OCLC's prototype is on a par with an excellent photocopy of the original version.

4. Conclusions

Future research on this topic should address itself to a number of organizational and economic issues. The issue of how to price electronic journals is one which will continue to puzzle entrepreneurs, as will the issue of what the unit of sale should be. Little research has been done by communication researchers

on current patterns of journal use and on invisible colleges. Applied research on this topic is likely to become more important to potential investors in electronic journal systems. It is also important from a less commercial standpoint. Scholarly, scientific, and technical communication is deserving of increased attention by members of our field.

This review of trends in the development of the electronic journal was written with some optimism. The concept of electronic journals remains largely a concept, yet one which is driving a great deal of research, development, and entrepreneurship. Many factors are converging to make the prospects more tangible and likely. Publishing standardization, the rising cost of print journal publication, and the increasing power and rapid decline in prices for microcomputers, storage, and output devices, give rise to a reasonable exptectation that electronic journals will be a viable channel for scholarly communication.

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